Dynamics and Acoustics in the Coupled Slope and Shelf Ocean. Simulation, Analysis and Synthesis of Integrated Acoustic and Oceanographic Data

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LONG-TERM GOALS

The overall goals are: i) to integrate the Shelf-Break PRIMER (Lynch *et al.*, 1997) and CMO (Williams, 1995) data into an interdisciplinary synthesis of CMO and PRIMER in the context of the NOPP Littoral Ocean Observing and Prediction System (LOOPS) (LOOPS Group, 1997); and, ii) to identify generally relevant physical processes for important physical/interdisciplinary interactions in this region.

OBJECTIVES

The objectives of this research are: i) complete dynamical simulations of the PRIMER and CMO physical fields; ii) collaborate with the acoustic modeling community in the use of coupled ocean prediction and acoustic propagation models for process and sensitivity studies; iii) determine effective methods of assimilating tomographic data, together with other *in situ* and remotely sensed data; and, iv) to explore, from a generic viewpoint, physical input into dominant interactions in the physical-acoustical-optical-biological-chemical-geological ocean.

APPROACH

The approach will be as follows: i) *Synthesis and Dynamical Studies* - the assimilation of all available data, via a dynamical model which has been tuned for the region through real-time forecasting and additional hindcasting, to allow for the synthesis of that data into a set of four-dimensional, dynamically consistent fields. These fields will then be used in a suite of dynamical and sensitivity studies, and will be made available to the PRIMER and CMO communities; ii) *OSSE* - model simulations will be used to explore sensitivities to the accomplished sampling strategy and assimilated data types. These types of simulations are referred to as Observation System Simulation Experiments (OSSE's). (Smith, 1993; The GLOBEC Special Contribution #2 includes a discussion on OSSE's - GLOBEC, 1994; Robinson *et al.*, 1998); iii) *Acoustic Tomography Studies* - to study the impact on the quality of physical fields via the assimilation of acoustic tomography data and the inversion of acoustic data; iv) to initiate an interpretation of the simulation and OSSE results from an interdisciplinary viewpoint.

WORK COMPLETED

Dynamical simulations were conducted in the PRIMER region. The simulation covers the period from February 16 to February 23, 1997, and utilizes continuously assimilated Seasoar, CTD and AXBT

synoptic data and atmospheric forcing. Historical data was used to provide large-scale background physical fields.

Physical dynamical simulations were conducted in the Coastal Mixing and Optics region to construct realistic four-dimensional hydrographic fields during Summer 1996 CMO experiment. The preliminary simulation for model tuning covers the period from August 05 to August 14 and is driven by initial and boundary conditions without updating. The initial conditions include Seasoar, CTD, AXBT and SST synoptic data sets from July and August 1996 complemented by historical data. The boundary conditions are the Orlanskii radiation conditions. The vertical diffusivity and viscosity coefficients are increased in the Nantucket Shoals area to represent strong tidal mixing in this region.

The MIT ocean acoustics group has joined the Range-Dependent Parabolic Equation Model (RAM) to the Harvard Ocean Prediction System in a simple fashion. Given temperature, salinity and bathymetry fields in HOPS netCDF format as the input, the acoustic model gives transmission losses in netCDF format as the output.

RESULTS

The PRIMER simulation depicts the evolution of the shelf-break front; the central event is the formation of vortex pairs. The CMO regional simulation shows the shelf-break front and associated circulation within that region. Acoustic fields have been generated for simulated physical fields in PRIMER region for February 1997.

IMPACT/APPLICATIONS

The completed four-dimensional simulations will be fundamentally useful for acoustic tomography research.

TRANSITIONS

Continuing research transitions are with the MIT Ocean Acoustics group.

RELATED PROJECTS

This project has relationships to the Harvard 6.1 research (“Dynamics of Oceanic Motions”), the Harvard 6.2 research (“Development of a Regional Coastal and Open Ocean Forecast System”), as well as external collaborations in conjunction with transitions.

REFERENCES

LOOPS Group, Development of a National Littoral Ocean Observing and Prediction System: Field Estimation via Interdisciplinary Data Assimilation, *Harvard Open Ocean Model Reports*, 56, reports in Meteorology and oceanography, Harvard University, Cambridge, MA, 1997.

Lynch, J.F., G.G. Gawarkiewicz, C.S. Chiu, R. Pickart, J.H. Miller, K.B. Smith, A.R. Robinson, K. Brink, R. beardsley, B. Sperry and G. Potty, Shelfbreak PRIMER: An integrated acoustic and

oceanographic field study in the Mid-Atlantic Bight, *Proceedings of the SWAC97 Shallow Water Acoustics Conference*, Beijing, PRC, 1997.

Williams, A.J., 3rd, Coastal Mixing and Optics Report I, *Technical Report*, Woods Hole Oceanographic Institution, Woods Hole, MA, 1995.